



**YENEPOYA UNIVERSITY**

**Deralakatte, Mangalore - 575018**

**REGULATIONS AND CURRICULUM GOVERNING  
POSTGRADUATE PROGRAM (MD) IN  
BIOCHEMISTRY**

**(CURRICULUM - EFFECTIVE FROM 2010-11)**

**ATTESTED**

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02.07.2010

**NOTIFICATION**

Sub: Curriculum for starting MD/MS in the departments of Anatomy,  
Biochemistry, Physiology, Pharmacology, Microbiology,  
and Forensic Medicine

Ref: Resolution of the Academic Council at its 4<sup>th</sup> Academic Council  
meeting held on 02.07.2010, supplementary agenda - 1

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The Academic Council at its 4<sup>th</sup> meeting and subsequently the Board of Management at its 11<sup>th</sup> meeting held on 02.07.2010 have resolved to approve the curriculum for starting the MD/MS in the departments of Anatomy, Biochemistry, Physiology, Pharmacology, Microbiology and Forensic Medicine.

This notification is issued for implementation with effect from the academic year 2010-2011.



**REGISTRAR**

To:

The Principal - YMC

Copy to:

1. Controller of Examinations
2. Academic Section

## MD BIOCHEMISTRY

### I. Goal:

The post graduate course M.D. in Biochemistry, should enable the student, to acquire an in depth knowledge of the fundamental principles of the subject of biochemistry, so that he/she can apply this knowledge, for understanding the basis of health and disease.

At the end of the course the student should have gained knowledge and expertise so that he/she is equipped to pursue a career in one or more of the following facets of biochemistry teaching, diagnostic work and research.

### II. Objectives:

At the end of the course the MD student should have gained knowledge in the following key areas of the subject:

1. The chemical and three dimensional structures of the various classes of biomolecules such as carbohydrates, proteins, lipids and nucleic acids as a prelude to understanding the correlation between structure and function.
2. An indepth insight into the metabolic pathways of the major classes of biomolecules, regulatory mechanisms, interactions, significance and alterations in disease states.
3. Mechanism of energy release, conservation, utilization and rearrangements thereof.
4. Role of micro and macro nutrients such as vitamins and minerals in health and the pathophysiology of nutritional disorders.
5. Mechanism involved in the storage, transmission and expression of genetic information
6. Biochemical techniques and methodology used to assess health and aid in the diagnosis and prognosis of diseases.
7. Develop skill in performing and interpreting data generated by advanced biochemical techniques such as electrophoresis, chromatography, enzyme assays, organ function tests etc.

### III. Outline of course contents

#### Theory:

#### Paper – I: Bioorganic Chemistry, Biophysical Chemistry and Biochemical Techniques

1. Proteins: Functional roles of proteins in humans. Charge and chemical properties of amino acids and proteins. Amino acid sequence determination, structure of proteins in details (primary, secondary, tertiary and quaternary). Structure of Insulin, Collagen, Hemoglobin and Myoglobin. Methods of study of structure of proteins and different levels of structural organization. Biologically important peptides.  
Conjugated proteins, lipoproteins and glycoproteins, structure of immunoglobulins.
2. Carbohydrates: Biological importance of carbohydrates, chemistry, structure and properties of monosaccharides, disaccharides and polysaccharides. Structure and functions of Heteropolysaccharides.
3. Lipids: Biological importance of Lipids. Chemistry and structure of simple, compound and derived lipids. Chemistry of steroids.
4. Nucleic Acids: Biological importance of Nucleic acids. Structure of nucleic acids (RNA, DNA and biologically important nucleotides). Methods of study of base sequence of DNA. Structure and functions of gene with respect to mammalian genome. Recombinant DNA technology. General principles of blotting techniques. PCR and its application in Medicine.
5. Biophysical chemistry:
  - i) pH, Buffers Henderson-Hasselbalch equation, principles and procedures of determination of pH,  $pO_2$ ,  $pCO_2$  (Blood gas analysis)
  - ii) Isotopes – detection and measurement of stable and radioactive isotopes; their application in Biochemistry.
  - iii) Bioenergetics – Free energy change, high-energy linkages, Redox potentials.

#### Paper-I Biochemical Techniques

- i) Chromatography: Principles and applications of paper, thin layer, ion exchange, gas phase and affinity chromatography. HPLC, gel filtration and its applications.
- ii) Electrophoresis: Principles, procedure and applications of paper, agarose gel, polyacrylamide, capillary, immune- electrophoresis. Isoelectric focusing.
- iii) Photometry, and spectrophotometer: principles and applications.
- iv) Flame Photometry: principle, procedure and applications.

- v) Ultra Centrifugation Techniques: Their applications in the study of lipoproteins.
- vi) Radio immune Assay: Competitive binding assay – Principles procedure and applications. Elisa- Principles and applications.
- vii) Ion selective electrodes: Their applications in medicine.
- viii) Cell fractionation: Isolation and purification of sub cellular particles, biochemical markers of different subcellular organelles.
- ix) Recent advances in Medical Laboratory Technology and Instrumentation: Semi Auto Analyser, Auto Analyzer, P.C.R. etc.

## **Paper–II. Intermediary Metabolism and Biochemical Genetics**

1. Introduction to intermediary metabolism, various methods of study of intermediary metabolism with examples. Their advantages and disadvantages.
2. Biological Oxidation – Structure of mitochondria, its role in biological oxidation, electron transport chain, mechanisms of electron transport and oxidative phosphorylation. Regulation of oxidative phosphorylation.
3. Carbohydrate metabolism: A detailed discussion of the metabolic pathways as it occurs in humans.
4. Amino acid metabolism: A detailed study of metabolism of the amino acids in humans.
5. Lipid metabolism: Fatty acids – Oxidation of saturated and unsaturated fatty acids, biosynthesis of fatty acids and triacylglycerols. Biosynthesis and degradation of phospholipids. Role of Phospholipids, biosynthesis and metabolism of cholesterol. Plasma lipoproteins, role of adipose tissue and liver in fat metabolism. Hyper and hypolipoproteinemias.
6. Integration of metabolic pathways of carbohydrate, protein and lipid. Regulation of metabolic pathways.
7. Biosynthesis and catabolism of purine and pyrimidine, nucleotides.
8. Protein biosynthesis in detail including regulation, mutations and their influences, latest aspects.

## **Paper–III. Enzymes, Nutrition and Specialized Tissues:**

### **1. Enzymes:**

- i) Classification, kinetics, specificity
- ii) Isoenzymes and coenzymes
- iii) Enzyme inhibitions-competitive, non- competitive, uncompetitive and allosteric, mechanism and application. Enzyme poisons
- iv) Active site of enzyme. Methods of locating the functional groups of active sites. Mechanism of enzyme action in detail. Enzyme regulations. Mechanism of specific enzymes.
- v) Immobilized enzymes – application.
- vi) Factors affecting enzyme catalysed reactions, Michaelis – Menten constant, Lineweaver – Burk plot, Ede- Hofstee plot.
- vii) Modification and supplement of dietary requirements in Health and disease.

### **2. Nutrition:**

- i) Detailed account of chemistry and biochemical roles of fat soluble and water- soluble vitamins, requirements, source and deficiency symptoms. Antivitamins.
- ii) Detailed account of metabolism of the micronutrients.
- iii) Energy metabolism – B.M.R., R.Q., Energy requirement at different stages, balanced diet. Diet planning in health and disease. SDA of foods.
- iv) Protein, carbohydrates and fat requirements, RDA, biological values of proteins. Protein energy malnutrition.
- v) Malabsorption syndromes, parenteral nutrition.
- vi) Modification and Supplementation of dietary requirements in Health and Disease.

### **3. Specialized tissues:**

- i) Muscle tissue- composition, mechanism of muscle contraction.
- ii) Nerve tissue – composition, transmission of nerve impulse, neurotransmitters.

- iii) Erythrocytes- composition and metabolism, blood clotting, other blood cells. Phagocytosis.
- iv) Connective tissue- composition, chemistry of collagen, elastin and other fibrous proteins.
- v) Adipose tissue including brown adipose tissue metabolism.
- vi) Bone and teeth- composition. Osteocalcin.
- vii) Composition of lens – Biochemical changes during cataractogenesis.
- viii) Structure of biomembranes, transport across membranes.

#### **Paper – IV clinical Biochemistry**

1. Basic concepts in laboratory investigations. Quality control.
2. Diagnostic enzymology- an exhaustive account.
3. Inborn errors of metabolism involving amino acid, carbohydrate lipid, purine, pyrimidine and porphyrin metabolism, mucopolysaccharidoses.
4. Diabetes mellitus: recent concepts
5. Plasma lipoproteins in health and disease.
6. Liver function tests, jaundice, hepatic coma.
7. Kidney function tests
8. Pancreatic function tests
9. Gastric function tests.
10. Endocrines- A detailed account of the mechanism of action, chemistry and regulatory role of hormones secreted by pituitary, pancreas, adrenal, thyroid, parathyroid and gonads. Endocrine disorders. Methods of assay and clinical interpretations.
11. Abnormal hemoglobins, Anemias, Thalassemias
12. Basic immunology, Immune system. T & B Lymphocytes, antigen presenting cells, humoral immunity lymphokines. Immune regulation. Monoclonal antibodies, application of immunological techniques, Oncogenes, biochemical tests for cancer.
13. Disorders of calcium and phosphorous metabolism.
14. Water and electrolyte balance, acid base balance – their disturbances.
15. Biochemical aspects of cancer. Tumour markers.
16. Composition of CSF, alterations in disease.
17. Laboratory Investigations in Myocardial Infarction.

## **Practical**

### **Part I- General Biochemistry**

1. Estimation of amino acids by ninhydrin method.
2. Estimation of protein by Folin's method.
3. Estimation of protein by dye- binding method.
4. Titration of amino acids – Formol titration and pK values.
5. Amino acid – paper chromatography, TLC. Two dimensional paper chromatography.
6. Gross separation of proteins – precipitation by salts.
7. Absorption spectra of Phe, Tyr, Trp (UV).
8. Ion exchange chromatography of amino acids.
9. Paper electrophoresis.
10. Separation of mono and disaccharides by paper chromatography.
11. Cholesterol estimation.
12. Estimation of triglycerides and phospholipids.
13. Estimation of DNA- Diphenylamine method
14. Absorption spectra of bases of nucleic acids.
15. Estimation of Vitamin C.
16. Estimation of Vitamin A.
17. Estimation of vitamin E.
18. Assay of trypsin, chymotrypsin.
19. Enzyme inhibitions.
20. Effect of pH, temperature on enzyme activity: Determination of  $K_m$ ,  $V_{max}$ .
21. PAGE electrophoresis. Molecular weight determination.
22. Gel chromatography. Molecular weight determination.
23. Immunodiffusion.
24. Affinity chromatography.

### **Part – II: Clinical Biochemistry**

1. Estimation of Plasma glucose – Glucose Oxidase Method and O- Toluidine Method.
2. Plasma Urea- Urease method.
3. Plasma Uric Acid – Uricase method
4. Serum creatinine \_ Jaffe's Kinetic and end – point methods
5. Cholesterol/ HDL Cholesterol by enzymatic method.



6. Albumin/ Globulin Ratio.
7. Serum calcium.
8. Flame photometry: Na, K, Li determination.
9. Serum bilirubin – direct and total.
10. Alkaline & Acid Phosphatases.
11. AST, ALT; UV Kinetic Methods and Colorimetric and assay of Gamma GT.
12. LDH Isoenzymes, CPK Isoenzymes.
13. Serum Amylase- SOmogyi Amylolytic method
14. Fe, Fe binding Capacity.
15. Agar gel Electrophoresis of Serum Proteins, Hb.
16. Lipoproteins – electrophoresis
17. 17 – Ketosteroids in urine
18. Estriol – by Fluorimetry.
19. Creatinine clearance.
20. Plasma Cl, HCO<sub>3</sub>, pH, PO<sub>2</sub>, PCO<sub>2</sub>. Blood gas analysis
21. CSF Analysis

**IV. Practical training in Biochemistry: (First half of 1 year):**

1. Introduction to research Methodology and Bio Statistics. One month Every postgraduate student should be given an introductory course in research methodology and research techniques. He/she must be taught as to how a research project can be planned and implemented. He/ she must also acquire a basic knowledge in the statistical methods and their applications.
2. Postings in departments of:
 

a) Medicine	3 months
b) Nephrology	15 days
c) Gastroenterology	15 days
d) Endocrinology	15 days
e) Cardiology	15 days

Clinical postings in the forenoon to be attended and to return to the department to do the experimental work in the afternoon.

Later half of I year, II year and first half of third year (2 years): Study and training in the department of Bio- chemistry.

Third Year (Later Half) Clinical Biochemistry (Exclusively) – 6 months.

Every postgraduate student in Biochemistry shall be posted to clinical Biochemistry Laboratory of the department where clinical investigations of the attached Hospital are done.

Student should be trained in collection of sample, carrying out investigations, interpretation, reporting of the results and maintenance of records of investigations. Quality Assurance.

Period: 6 Months/ Year.

**Skills to be acquired during the clinical postings:**

**Medical and other postings:** During posting in medical and other related departments, the student should acquire relevant knowledge and skills. These generally include:

1. Clinical examination of a patient.
2. Investigations to be carried and their relevance.
3. Drawing of blood, collection of urine and other specimens for investigations and their storage.
4. Biopsy techniques and handling of biopsy material to be sent for relevant tests/ investigations.
5. Interpretation of laboratory data, X- ray and biopsy results.

**V. Practical record:**

Student should maintain Practical Record for General & Clinical Biochemistry separately of all practicals done during the course and submit at the time of University Examination after duly certified by the Head of the Department.

**VI. Seminars, Journal Clubs**

Students of Biochemistry should be actively involved in departmental seminars and Journal Clubs. A record should be maintained for each student and the list of seminars and paper presented in Journal Club by each student should be presented at the time of University Examination. These should be held fortnightly.

Further students should participate in undergraduate teaching, particularly in practicals and tutorials.

For model check lists please see chapter. IV.

**VII. Dissertation**

Every student should submit a dissertation on a selected research problem involving laboratory investigations. The dissertation has to be prepared by the student and submitted to the University 6 months prior to the final examination as notified by the University. For

further details please see Chapter I, Sl. No. 9. Acceptance of dissertation is a pre-requisite for appearing in the university examination.

### **VIII. Periodical Assessment and Progress Reports:**

Every student should be assessed. For assessment of performance, participation in Seminars, Journal Clubs, standardization of analytical techniques and involvement in clinical laboratory investigations should be taken into consideration. Please see Chapter IV for details.

### **IX. Scheme of Examination**

**A. Theory** – There shall be four papers of 100 marks each. Each paper shall be of three hours duration. Each paper shall have two long essay questions of 20 marks (20x2 =40), and six short essay questions of 10 marks (10x6 =60).

The distribution of topics/ chapters for the papers will be as under\*.

Paper – I – Bio- Organic Chemistry, Biophysical Chemistry and Biochemical Techniques.

Paper – II – Intermediary metabolism and biochemical genetics.

Paper – III – Enzymes, Nutrition and Specialised Tissues.

Paper – IV – Clinical Biochemistry

**\*The topics assigned to the different papers are given as general guidelines. A strict division of subjects may not be possible. Some overlapping of topics is inevitable. Students should be prepared to answer the overlapping topics.**

***Questions on recent advances may be asked in any or all paper***

### **B. Practical Examination : 200 marks**

**Duration: Two days**

Part I – Laboratory procedures in General Biochemistry

Part II – Clinical examination of a patient and relevant investigations in clinical Biochemistry.

The assignment of work under part I and part II should begin on day I and the candidate is expected to complete the work by forenoon on second day, so that viva voce and pedagogy examinations are held on the second day afternoon.

### **Part I- General Biochemistry**

1. Qualitative identification of any Biological fluid (urine, CSF, Pleural fluid) – interpretation and discussion. 20 marks

2. Experiments on enzymes kinetics.  
 Eg. Determination of pH optimum  
 Or Km value or temperature optimum etc. 40 marks

3. Experiments involving chromatography or electrophoresis  
 to be given, separation and identification of amino acids or  
 carbohydrates by chromatography or separation and  
 interpretation of serum proteins, lipoproteins, isoenzymes of  
 (LDH & CPK) by electrophoresis to be given. 40 marks

**TOTAL** **100 marks**

**Part II – Clinical Examination & Clinical Chemistry Experiments**

Each candidate is expected to perform clinical examination and list the laboratory investigations he/she deems appropriate for the case. The candidate presents the case to the examiners, the examiner would select two or three laboratory investigations, which the candidate will conduct.

- 1. Clinical examination and discussion (Thirty minutes) 25 marks
- 2. Clinical Biochemistry (Three Relevant Biochemical investigations including a separation procedure such as electrophoresis of plasma proteins) 75 marks

**C. Viva – Voce**

1) Viva – Voce Examination: 80 Marks

Viva voce examination will be conducted conjointly by all the examiners to test comprehension, analytical approach, expression and interpretation of facts. Student shall also be given case reports. Charts for interpretation. It includes discussion on dissertation.

2) Pedagogy Exercise: 20 Marks

A topic would be given to each candidate along with the Practical Examination question paper on the first day. Student is asked to make a presentation on the topic on the second day for 8-10 minutes.

D. Maximum Marks for	Theory	Practicals	Viva – voce	Total
M.D. Biochemistry	400	200	100	700

## **X. Recommended Books and Journals**

1. Berg JM, Tymoczko JL Stryer L, **Biochemistry** – WH Freeman and Company, New York, 5<sup>th</sup> Edition, 2002.
2. Devlin TM, **Textbook of Biochemistry with clinical correlations** – Wiley –Liss, New York, 5<sup>th</sup> Edition, 2002.
3. Rose BD, **Clinical Physiology of acid – base and electrolyte disorders** – McGraw- Hill International edition, New York, 4<sup>th</sup> Edition , 1994.
4. Coleman WB, **Molecular Diagnostics for the clinical laboratorian** – Hamana Press, New Jersey, 4<sup>th</sup> Edition, 1997.
5. Burtis CA and Ashwood ER, **Tietz Fundamentals of Clinical Chemistry**, Harcourt (India) Ltd., 5<sup>th</sup> Ed, 2001.
6. Kaplan LA and Pesee AG, **Clinical Chemistry: Theory, analysis and correlation** – CV Mosby and Co. St. Louis, MO., 2<sup>nd</sup> edition, 1989.
7. Voet D and Voet J, **Biochemistry** – John Wiley and Sons, New York, 2<sup>nd</sup> Edition, 1999.
8. Gowenlock and Bell, **Varley's Practical Clinical Biochemistry** – CBS, New Delhi, 6<sup>th</sup> edition, 1988.
9. Lehninger AL, Nelson DL and Cox MM, **Lehninger** – CBS Publishers, New Delhi, 3<sup>rd</sup> Edition, 2002.
10. **Harper's Illustrated Biochemistry**, Murray RK, Grannar DK, Mayes PA, Rodwell VW, 26<sup>th</sup> ed., Mc Graw – Hill, 2003.
11. **Medical Biochemistry**, N.V Bhagavan, Academic Press, 4<sup>th</sup> Ed. 2002

### **Journals and other periodicals:**

1. Annual Review of Biochemistry.
2. Clinical Chemistry (J).
3. Trends in Biochemical Sciences.
4. Clinical Chemistry Reviews.
5. Medical Biochemistry (J).
6. Recent Advances in Endocrinology and Metabolism.
7. Essays in Biochemistry, Biochemical Society, UK.
8. Indian Journal of Clinical Biochemistry (J).
9. Indian Journal of Medical Research (J).
- 10.. Indian Journal of Biochemistry and Biophysics.

## **ADDITIONAL READING:**

1. Compendium of recommendations of various committees on Health and Development (1943- 1975). DGHS, 1985 Central Bureau of Health Intelligence. Directorate General of Health Services, min. of Health and Family Welfare, Govt. of India. Nirman Bhawan, New Delhi. P – 335.
2. National Health Policy, Min. of Health & Family Welfare, Nirman Bhawan, New Delhi, 1983.
3. Santosh Kumar, The elements of Research, writing and editing 1994, Dept. of Urology, JIPMER, Pondicherry
4. Srinivasa D K et al, Medical Education Principles and Practice, 1995. National Teacher Training Centre, JIP'MER, Pondicherry
5. Indian Council of Medical Research, "Policy Statement of Ethical considerations involved in Research on Human Subjects", 1982, I.C.M.R, New Delhi.
6. Code of Medical Ethics framed under section 33 of the Indian Medical Council Act, 1956. Medical Council of India, Kotla Road, New Delhi.
7. Francis CM, Medical Ethics, JP Publications, Bangalore, II edn., 2004.
8. Indian National Science Academy, Guidelines for care and use of animals in Scientific Research, New Delhi, 1994.
9. International Committee of Medical Journal Editors, Uniform requirements for manuscripts submitted to biomedical journals, N Engl J Med 1991; 424-8.
10. Kirkwood B,R, Essentials of Medical Statistics, 1<sup>st</sup> Ed., Oxford: Blackwell Scientific Publications 1988.
11. Mahajan BK, Methods in Bio statistics for medical students, 5<sup>th</sup> Ed. New Delhi, Jaypee Brothers Medical Publishers, 1989.
12. Raveendran and B Gitanjali, A Practical approach to PG dissertation, New Delhi, JP Publications 1998.